CHAPTER 4

COLLISION RISK FOR SIX SEABIRD SPECIES IN THE FIRST BELGIAN OFFSHORE WIND FARM ZONE

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Abstract

Collision of seabirds with turbines is a direct impact of offshore wind farms (OWFs) resulting in additional mortality. The numerous operational and planned offshore wind farms in the North Sea, an area of great importance for millions of seabirds during their different life stages, raise concern about the possible impact they might have on seabird populations.

Now that a first wind farm zone in the Belgian part of the North Sea, comprising nine OWFs, is (nearly) completed, we assessed the number of possible seabird collision victims based on the latest available knowledge on collision risk modelling.

A total of 69.5 ± 53.0 casualties per year for six selected seabird species, which are the most abundant inside the Belgian OWFs, are estimated. This total figure arises to 290.3 ± 205.4 depending on the source of the avoidance rates in the model. Of the six species included in the study, the highest number of collisions are expected for greater and lesser black-backed gull. Despite considerable uncertainty about the absolute number of collisions, the model identifies which species face the highest risk and shows great value in the comparison of different scenarios for wind farm developments and should be used as a tool for strategic marine planning at a national or regional scale. With an increasing number of OWFs built and planned in the North Sea, population level effects caused by additional mortality through collisions cannot be excluded and developments could conflict with seabird conservation goals.

1. Introduction

The collision of seabirds with the rotor blades of turbines is a direct impact of offshore wind farms (*e.g.* Fox et al. 2006; Drewitt & Langston 2006; Furness *et al.* 2013). The resulting additional mortality may have a substantial impact at a population level because seabirds are long-lived species with a delayed maturity and small clutch size (Croxall & Rothery 1991; Sæther & Bakke 2000; Stienen *et al.* 2007).

Internationally highly important numbers of seabirds breed along the North Sea coasts, totalling more than 4 million individuals. These birds make intensive use of the North Sea for feeding during at least part of the year (Tasker *et al.* 1987; Mitchell *et al.* 2000). During autumn and spring, an estimated number of 1.0-1.3 million seabirds annually migrate through the 'migration bottleneck' of the Southern North Sea, including the Belgian part of the North Sea (Seys 2002; Stienen *et al.* 2007). The large number of operational and planned OWFs in this area therefore raised concern about the impact on seabird communities. In the first Belgian zone for renewable energy, oriented perpendicular to the main seabird migration route, nine wind farms are operational (see chapter 1). Prior to developments in a second area, we intend to assess the number of likely seabird collision victims based on the latest available knowledge. Searching for carcasses, as it is done in wind farms on land, is not an option offshore, so the only possible way to assess this impact is by modelling the risk of collision for birds. These collision risk models (CRM) are based on input data related to wind farm configuration and turbine dimensions, as well as species-specific parameters such as bird dimensions, flight activity and local bird density.

2. Material and methods

2.1. Research strategy

Accurate information on turbine dimensions is available for all nine OWFs in Belgian waters. Also, post-construction seabird surveys have been conducted for over five years in two of these wind farms (Vanermen *et al.* 2016, 2019). We used the resulting post-construction seabird density data to estimate the total number of collision victims within all Belgian OWFs for the six most abundant seabird species occurring inside the wind farms. Post-construction data are not yet available for more recently built wind farms, but the above-mentioned density data were used as a proxy for the other wind farms.

2.2. Collision risk modelling

Estimating bird collisions at sea can be done using a collision risk model (CRM) that calculates the risk per species based on technical wind farm and turbine specifications, bird-related parameters and bird densities. The CRM most frequently used is the one developed by Band (2012). Masden (2015) developed a CRM, based on the Band model, that includes uncertainty and variability of the input variables. The Masden (2015) model was further improved by McGregor *et al.* (2018) to develop a stochastic version of the Band (2012) collision risk model, providing a more robust and transparent method of accounting for uncertainty in the estimation of seabird collision rates.

The Band model (Band 2012) has undergone several iterations over the years and now provides four different options for calculating collision risk. Option 3 of the extended model uses species-specific flight height distributions from Johnston *et al.* (2014), in contrast to the basic model that assumes a uniform distribution of the flight height between the lowest and the highest level of the rotor swept area. As option 3 is considered the most realistic calculation (McGregor *et al.* 2018), this is what we used.

The stochastic CRM (sCRM) is available in two forms: a Shiny app based on the R-code, available as an online tool (https://dmpstats.shinyapps.io/avian_stochcrm/) and as a package that can be downloaded and run locally (https://github.com/dmpstats/stochCRM). We used the online application. The input variables needed for the sCRM are further described in the paragraphs below.

2.3. Species selection

The focus of this study was on the six most abundant seabird species inside the Belgian offshore wind farms: black-legged kittiwake *Rissa tridactyla*, lesser black-backed gull *Larus fuscus*, great black-backed gull *Larus marinus*, herring gull *Larus argentatus*, common gull *Larus canus* and northern gannet *Morus bassanus*. Other species were not selected because of insignificant post-construction densities inside the wind farms or because they are at low risk

Table 1. Bird related input data for the stochastic collision risk model

Species	Northern gannet	Common gull	Lesser black-backed gull	Herring gull	Great black-backed gull	Black-legged kittiwake
Avoidance rate (%)[1]	99.9	99.8	99.8	99.9	99.6	99.8
SD Avoidance rate (%)[1]	0.03	0.07	0.06	0.05	0.11	0.06
Body_Length (m)[2]	0.94	0.41	0.58	0.6	0.71	0.39
SD Body_Length (m)[2]	/	/	0.03	/	/	0.005
Wingspan (m)[2]	1.725	1.11	1.43	1.44	1.58	1.08
SD Wingspan (m)[2]	/	/	0.0375	/	/	0.0625
Flight_Speed (m/s)[1]	13.33	9.8	10.13	9.68	9.78	8.71
SD Flight_Speed (m/s)[1]	4.24	3.63	3.93	3.47	3.65	3.16
Nocturnal_Activity (% of diurnal activity)	0.25[3]	0.5[3]	0.43[4]	0.01[4]	0.5[3*]	0.5[3]
Flight	Flapping	Flapping	Flapping	Flapping	Flapping	Flapping
Proportion Flight	1	1	1	1	1	1

[1] Skov *et al.* (2018), [2] Snow & Perrins (1998), [3] Garthe & Hüppop (2004; *common gull not mentioned, therefore we took the same value as for other gull species mentioned in this study), [4] Gyimesi *et al.* (2017).

of collision due to their low-flying height (*e.g.* razorbill *Alca torda*, common guillemot *Uria aalge*). Great cormorant *Phalacrocorax carbo* was not considered either, despite the fact that this species is frequently observed perching on the jacket turbine foundations in the C-Power wind farm on the Thornton Bank (Vanermen *et al.* 2019). This species, however, was rarely observed flying inside the wind farm, resulting in negligible densities of flying birds.

2.4. Bird related input data

Avoidance rates are taken from Skov *et al.* (2018), who determined these in an empirical study. Body length and wingspan are taken from Snow and Perrins (1998). Flight type for seabirds is regarded as flapping, not gliding. Proportion in flight is set at 1, as the density data are based on flying birds only.

2.5. Bird density data

Monthly post-construction bird surveys started in 2010 in the Belwind OWF on the Bligh Bank and in 2013 in the C-Power OWF on the Thornton Bank and were continued for five years. Details on these surveys can be consulted in Vanermen *et al.* (2016, 2019). During these surveys flying birds and birds on the water were counted separately. We selected only the flying birds to calculate seasonal densities as input for the sCRM.

Post-construction data are not yet available for the other wind farms, but the post-construction density data of the Bligh Bank and Thornton Bank offshore wind farms were used as a proxy for the other wind farms. The Thorton Bank data were used for the Southern parks (Norther, C-Power and Rentel), the Bligh Bank data for the northern wind farms (Northwind, Seastar, Nobelwind, Belwind, Northwester 2 and Mermaid; fig. 1).

2.6. Turbine related input data

The variables of the wind farms and wind turbines are given in table 2. Wind farm and turbine specific input data were collected with the help of the wind farm operators. Rotor speed and pitch were taken from Gyimesi *et al.* (2018). Informations on turbine activity per month were taken from Masden *et al.* (2015).

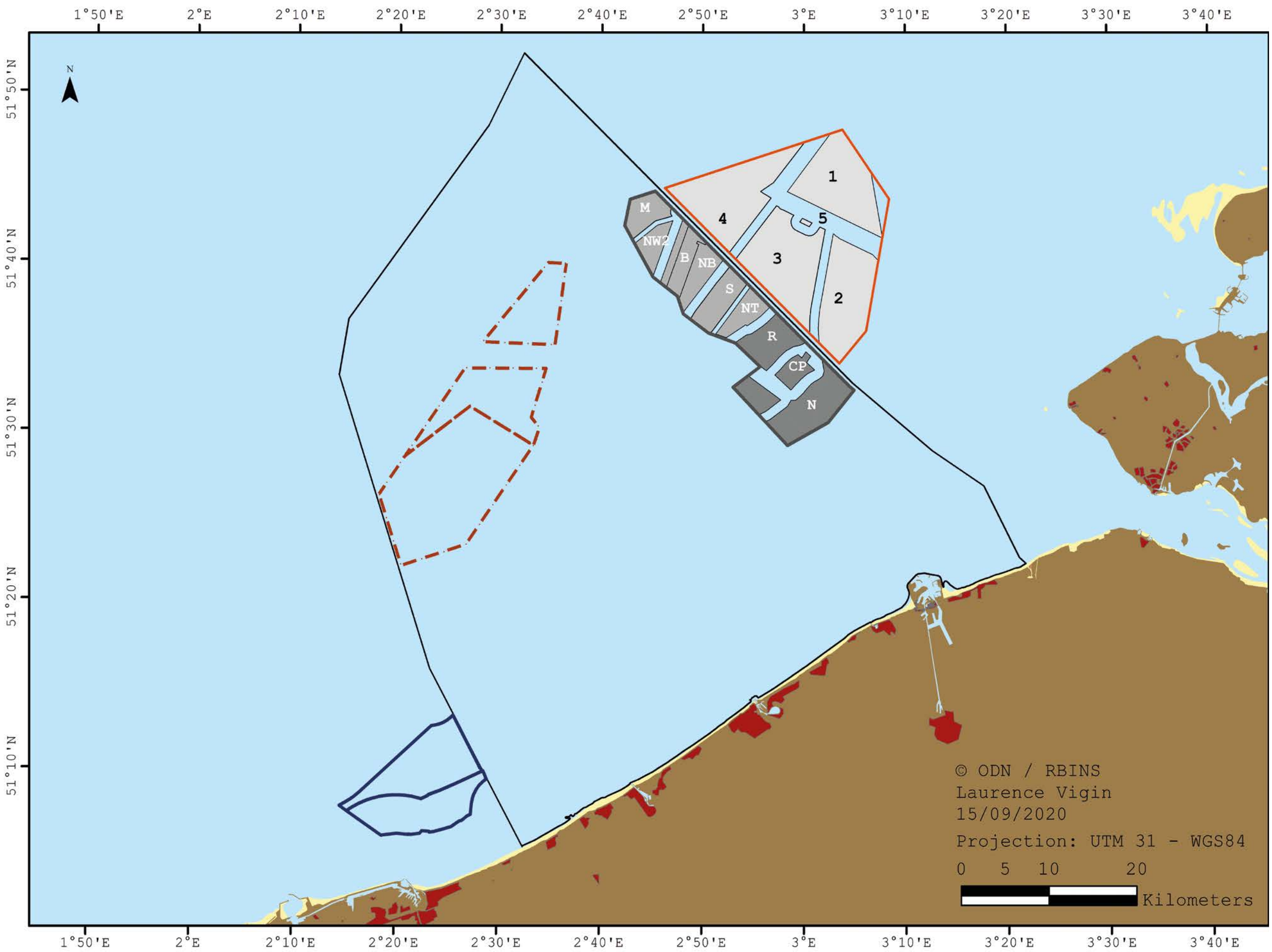

Figure 1. Map of Belgian part of the North Sea with indication of the nine offshore wind farms (OWFs) that are operational or being finalized. For the darker grey OWFs, the Thornton Bank bird density data were used, for the lighter grey, the Bligh Bank density data were used. The second zone for wind energy is indicated by the dashed polygon, the Borssele wind farm zone (in the adjacent Dutch waters by the red polygon and the French wind farm zone near Dunkerque by the blue polygon.

Table 2. Wind farm and turbine related input data for the stochastic collision risk model

	N of turbines	Width (km)	Latitude (°)	Tidal offset (m)	Turbine model (MW)	N of blades	Rotor radius (m)	Air gap (m)	Max blade width (m)	Rotor speed (rpm)	Pitch (°)
Norther	44	4.3	51.52	4.3	8.4	3	82	25	5.4	10.95	5.2
C-Power	54	4.4	51.55	4.3	6.15	3	63	32	5	12.22	5.6
Rentel	42	4.7	51.59	4.3	7.35	3	77	28.5	5	11.62	5.4
Northwind	72	3.1	51.62	4.3	3	3	56	27	4	14.85	6
Seastar	30	2.8	51.64	4.3	8.4	3	83.5	25.5	5.4	10.95	5.2
(No)Belwind*	106	5.1	51.67	4.3	3.3	3	56	27	4	14.85	6
Northwester 2	23	4.2	51.69	4.3	9.5	3	82	24.5	5.4	10.52	5.1
Mermaid	28	3.6	51.71	4.3	8.4	3	83.5	25.5	5.4	10.95	5.2

* the Nobelwind OWF is built around the Belwind OWF and therefore Belwind and Nobelwind are considered as one project. Belwind and Nobelwind have different turbines (Vestas V90 and Vestas V112 respectively). We used the Nobelwind turbine dimensions as a worst-case scenario.

Table 3. Post-construction density data (mean (n/km²) ± SD) of flying individuals of six seabird species inside the wind farms on the Bligh Bank and the Thornton Bank in winter (December, January, February), spring (March, April, May), summer (June, July, August) and autumn (September, October, November)

Thornton Bank (9/2013-12/2018)						
Season	Northern gannet	Common gull	Lesser black-backed gull	Herring gull	Great black-backed gull	Black-legged kittiwake
Winter	0.00 ± 0.00	0.43 ± 0.76	0.01 ± 0.04	0.01 ± 0.04	0.09 ± 0.17	0.49 ± 0.58
Spring	0.00 ± 0.00	0.00 ± 0.00	0.22 ± 0.34	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Summer	0.02 ± 0.06	0.00 ± 0.00	0.20 ± 0.14	0.00 ± 0.00	0.04 ± 0.06	0.00 ± 0.00
Autumn	0.00 ± 0.00	0.04 ± 0.11	0.04 ± 0.11	0.01 ± 0.04	0.14 ± 0.22	0.09 ± 0.25
Bligh Bank (10/2010-4/2015)						
Season	Northern gannet	Common gull	Lesser black-backed gull	Herring gull	Great black-backed gull	Black-legged kittiwake
Winter	0.00 ± 0.00	0.14 ± 0.24	0.04 ± 0.07	0.05 ± 0.17	0.04 ± 0.09	0.64 ± 0.64
Spring	0.03 ± 0.07	0.02 ± 0.04	0.27 ± 0.45	0.03 ± 0.08	0.02 ± 0.08	0.14 ± 0.34
Summer	0.00 ± 0.00	0.00 ± 0.00	0.16 ± 0.19	0.00 ± 0.00	0.02 ± 0.05	0.00 ± 0.00
Autumn	0.03 ± 0.09	0.01 ± 0.03	0.04 ± 0.10	0.00 ± 0.00	0.20 ± 0.27	1.14 ± 0.19

3. Results

3.1. Post-construction bird densities

The resulting density data of flying individuals of the six-target species (table 3) were used to calculate the annual number of collision victims.

3.2. sCRM results

The sCRM was run for 1000 iterations of the input variables, resulting in an overall number of collision victims ± standard deviation. This was done for each wind farm and then the model outputs were summed to get an overall number of collisions per species for the entire Belgian wind farm zone (table 4).

As such, a total of 69.5 ± 53.0 casualties per year for the six selected seabird species are expected. The highest numbers are expected for great and lesser black-backed gulls, with respectively 54.3% and 27.1% of the total number of collisions. Only 0.7% of the collisions are expected to be Northern gannets.

4. Discussion

The resulting collision estimates are significantly lower than the outcome of an earlier study on collision risk in the BPNS. Brabant and Vanermen *et al.* (2015) estimated a yearly 102 [22; 704] seabird collisions for a single wind farm (Belwind) for the same six

Table 4. sCRM option 3 output resulting in a total estimated number of collisions per species per year (± SD) for the eight Belgian offshore wind farms in the first zone for renewable energy

	Winter	Spring	Summer	Autumn	N collisions/year (± SD)
Black-legged kittiwake	3.2 ± 2.9	1.1 ± 1.3	0.0 ± 0.0	1.0 ± 0.9	5.3 ± 7.4
Common gull	4.6 ± 5.0	0.4 ± 0.6	0.0 ± 0.0	0.6 ± 0.7	5.5 ± 9.1
Great black-backed gull	8.2 ± 6.7	3.9 ± 4.5	4.4 ± 3.6	21.3 ± 18.3	37.7 ± 45.8
Herring gull	0.9 ± 1.6	0.7 ± 1.2	0.0 ± 0.0	0.1 ± 0.2	1.7 ± 4.2
Lesser black-backed gull	1.2 ± 1.1	10.3 ± 9.1	5.3 ± 4.3	2.1 ± 1.9	18.8 ± 23.6
Northern gannet	0.0 ± 0.0	0.2 ± 0.2	0.1 ± 0.1	0.2 ± 0.3	0.5 ± 0.8
Total	18.1 ± 9.0	16.5 ± 10.3	9.7 ± 5.6	25.2 ± 18.4	69.5 ± 53.0

species. This exceeds by far the results of this updated calculation where we expect a total of 69.5 ± 53.0 collisions per year for nine wind farms. The main reason for this strong decrease is the use of the empirical avoidance rates from Skov *et al.* (2018). These vary between 0.996 and 0.999 for the selected species (see table 1). In the 2015 study we applied an avoidance rate of 0.976 for all species, a figure taken from Krijgsveld *et al.* (2011). This implies that the number of collisions decreases with a factor 6 to a factor 24 only by updating the avoidance rate. The discussion on the avoidance rates is still ongoing within the scientific community. Bowgen and Cook (2018) state that the empirical avoidance rates of Skov *et al.* (2018) cannot be used directly in the sCRM as they do not incorporate model error or how birds respond in relation to other factors, for example weather conditions. Using the avoidance rates recommended by Bowgen and Cook (2018) increases the number of estimated collisions with a factor ranging from 2.5 to 15 for the species included in this study. The overall number of collisions by the nine OWFs would then be 290.3 ± 205.4 instead of 69.5 ± 53.0.

Leemans *et al.* (2019) also used the sCRM to estimate collisions of lesser black-backed gull and black-legged kittiwake for different development scenarios of offshore wind farms in the North Sea. For the first Belgian wind farm zone, *i.e.* the nine wind farms we included, they estimate that 41 lesser black-backed gulls and 3 black-legged kittiwakes would collide per year. Our calculations result in 18.8 ± 23.6 annual collisions for lesser black-back gull and 5.3 ± 7.4 black-legged kittiwakes. The difference for lesser black-backed gull can be explained by the input data for flying altitude. While we used the species-specific flight height distributions as modelled by Johnston *et al.* (2014), Leemans *et al.* (2019) used GPS logger data of lesser black-backed gulls from the Netherlands, Belgium and England (Gyimesi *et al.* 2017). These GPS logger data showed that approximately 34% lesser black-backed gulls fly at the collision risk height between 25 and 150 m (Gyimesi *et al.* 2017), while for the modelled distributions of Johnston *et al.* (2014) this is only 22%. Another explanation for the difference can be found in the seabird density data being used. Leemans *et al.* (2019) made use of data presented by van der Wal *et al.* (2018), which are higher than the post-construction density data used in this study. The other input variables Leemans *et al.* (2019) used were identical to this study.

The results also nicely reflect the dimensions and density of the turbines in different wind farm: turbines with a larger area between the sea surface and the lower tip of the rotor (*i.e.* air gap, table 2) will result in lower number of collision victims (*e.g.* C-Power) and a high turbine density will result in higher number of collisions (*e.g.* (No) Belwind). These conclusions need to be taken into account in the planning and design of future developments in the North Sea (*e.g.* the second wind farm zone in the BPNS) *e.g.* by requiring developers to install fewer, larger turbines.

There is large uncertainty about the absolute number of collisions, and that outcome largely differs depending on the input variables of which the avoidance rates and the flight speed of birds have the largest impact. The approach is, however, very useful for use in a relative manner to compare different scenarios for wind farm development which is also recommended by Cuttat and Skov (2020) and to identify which species face the highest risk of collision. Furthermore, these collision risk assessments become increasingly relevant when they are conducted at a national or regional scale as a means of strategic marine planning, opposed to being applied during the licensing or consenting procedure of a single wind farm. Nevertheless, these results indicate the order of magnitude of the number of collisions. In our study, the highest number of collisions are to be expected for greater and lesser black-backed gull. These species were also identified by Furness *et al.* (2013) as being most vulnerable to collision mortality. Large gull species have the highest risk of collision because they fly at rotor height more frequently compared to the other species in this study (*e.g.* northern gannet) and their relatively high density inside the OWFs. With an increasing number of OWFs built and planned in the North Sea, population level effects caused by additional mortality through collisions cannot be excluded and developments could conflict with seabird conservation goals.

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Annex: collision estimates per wind farm

Norther	Winter	Spring	Summer	Autumn	Total/year
Black-legged kittiwake	0.3 ± 0.6	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.3	0.4 ± 0.7
Common gull	0.7 ± 2.0	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.3	0.8 ± 2.0
Great black-backed gull	1.7 ± 3.6	0.0 ± 0.0	0.7 ± 1.6	2.5 ± 7.0	4.9 ± 8.1
Herring gull	0.0 ± 0.1	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.1	0.1 ± 0.2
Lesser black-backed gull	0.1 ± 0.2	1.1 ± 2.4	0.7 ± 1.3	0.3 ± 0.6	2.1 ± 2.8
Northern gannet	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.1	0.0 ± 0.0	0.0 ± 0.1

C-Power	Winter	Spring	Summer	Autumn	Total/year
Black-legged kittiwake	0.2 ± 0.5	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.2	0.3 ± 0.5
Common gull	0.9 ± 2.4	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.3	1.0 ± 2.4
Great black-backed gull	1.3 ± 2.8	0.0 ± 0.0	0.6 ± 1.1	1.9 ± 3.9	3.7 ± 5.0
Herring gull	0.0 ± 0.2	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.2	0.1 ± 0.2
Lesser black-backed gull	0.1 ± 0.2	1.1 ± 3.0	0.6 ± 1.5	0.3 ± 0.7	2.0 ± 3.5
Northern gannet	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0

Rentel	Winter	Spring	Summer	Autumn	Total/year
Black-legged kittiwake	0.2 ± 0.5	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.2	0.3 ± 0.5
Common gull	0.8 ± 1.8	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.2	0.9 ± 1.8
Great black-backed gull	1.2 ± 2.4	0.0 ± 0.0	0.5 ± 1.2	1.8 ± 3.9	3.5 ± 4.7
Herring gull	0.0 ± 0.1	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.1	0.1 ± 0.2
Lesser black-backed gull	0.1 ± 0.2	0.9 ± 2.2	0.6 ± 1.1	0.3 ± 0.6	1.8 ± 2.5
Northern gannet	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.1	0.0 ± 0.0	0.0 ± 0.1

Northwind	Winter	Spring	Summer	Autumn	Total/year
Black-legged kittiwake	0.6 ± 1.3	0.3 ± 0.6	0.0 ± 0.0	0.2 ± 0.4	1.0 ± 1.5
Common gull	0.6 ± 1.7	0.1 ± 0.3	0.0 ± 0.0	0.1 ± 0.2	0.8 ± 1.7
Great black-backed gull	1.1 ± 2.1	1.1 ± 2.1	0.8 ± 1.5	4.3 ± 8.7	7.3 ± 9.3
Herring gull	0.3 ± 1.0	0.2 ± 0.8	0.0 ± 0.0	0.0 ± 0.0	0.5 ± 1.3
Lesser black-backed gull	0.3 ± 0.5	2.0 ± 3.9	1.0 ± 2.2	0.4 ± 0.7	3.7 ± 4.6
Northern gannet	0.0 ± 0.0	0.1 ± 0.2	0.0 ± 0.0	0.1 ± 0.2	0.1 ± 0.2

Seastar	Winter	Spring	Summer	Autumn	Total/year
Black-legged kittiwake	0.3 ± 0.7	0.1 ± 0.3	0.0 ± 0.0	0.1 ± 0.2	0.5 ± 0.8
Common gull	0.2 ± 0.4	0.0 ± 0.1	0.0 ± 0.0	0.0 ± 0.1	0.2 ± 0.4
Great black-backed gull	0.5 ± 1.0	0.4 ± 1.0	0.3 ± 0.6	1.6 ± 3.2	2.7 ± 3.5
Herring gull	0.1 ± 0.5	0.1 ± 0.3	0.0 ± 0.0	0.0 ± 0.0	0.2 ± 0.5
Lesser black-backed gull	0.1 ± 0.3	1.0 ± 2.3	0.5 ± 1.1	0.2 ± 0.4	1.7 ± 2.6
Northern gannet	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.1	0.0 ± 0.1

Nobelwind	Winter	Spring	Summer	Autumn	Total/year
Black-legged kittiwake	1.1 ± 2.2	0.5 ± 1.0	0.0 ± 0.0	0.3 ± 0.6	1.9 ± 2.5
Common gull	1.0 ± 3.0	0.2 ± 0.5	0.0 ± 0.0	0.1 ± 0.3	1.3 ± 3.0
Great black-backed gull	1.5 ± 3.3	1.5 ± 3.7	0.9 ± 2.0	5.7 ± 12.0	9.6 ± 13.2
Herring gull	0.3 ± 1.1	0.3 ± 0.8	0.0 ± 0.0	0.0 ± 0.0	0.6 ± 1.4
Lesser black-backed gull	0.3 ± 0.7	2.7 ± 6.2	1.2 ± 2.4	0.5 ± 1.2	4.9 ± 6.8
Northern gannet	0.0 ± 0.0	0.1 ± 0.2	0.0 ± 0.0	0.1 ± 0.2	0.2 ± 0.2

Northwester 2	Winter	Spring	Summer	Autumn	Total/year
Black-legged kittiwake	0.2 ± 0.4	0.1 ± 0.2	0.0 ± 0.0	0.1 ± 0.1	0.4 ± 0.5
Common gull	0.2 ± 0.4	0.0 ± 0.1	0.0 ± 0.0	0.0 ± 0.1	0.2 ± 0.4
Great black-backed gull	0.5 ± 0.9	0.4 ± 0.8	0.3 ± 0.6	1.6 ± 2.8	2.8 ± 3.1
Herring gull	0.1 ± 0.2	0.1 ± 0.2	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.3
Lesser black-backed gull	0.1 ± 0.2	0.7 ± 1.5	0.3 ± 0.8	0.1 ± 0.3	1.2 ± 1.7
Northern gannet	0.0 ± 0.0	0.0 ± 0.4	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.1

Mermaid	Winter	Spring	Summer	Autumn	Total/year
Black-legged kittiwake	0.2 ± 0.5	0.1 ± 0.3	0.0 ± 0.0	0.1 ± 0.2	0.4 ± 0.6
Common gull	0.2 ± 0.7	0.0 ± 0.1	0.0 ± 0.0	0.0 ± 0.1	0.3 ± 0.7
Great black-backed gull	0.5 ± 1.0	0.5 ± 0.9	0.3 ± 0.7	2.0 ± 4.1	3.3 ± 4.4
Herring gull	0.1 ± 0.2	0.1 ± 0.2	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.2
Lesser black-backed gull	0.1 ± 0.2	0.7 ± 1.6	0.4 ± 0.9	0.1 ± 0.3	1.4 ± 1.9
Northern gannet	0.0 ± 0.0	0.0 ± 0.1	0.0 ± 0.0	0.0 ± 0.1	0.0 ± 0.1